College Medical and Health Techniques

Department: Radiology technique

Physics of Computed Tomography

Second Semester

Weeks 1-2: Computed tomography scan (CT scan)

By

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Radiation: is energy that comes from a source and travels through space at the speed of light. This energy has an electric field and a magnetic field associated with it, and has wave-like properties. You could also call radiation "electromagnetic waves".

❖ **The x–ray:** is a form of the electromagnetic radiation (EMR) of very short wave length ($\lambda \leq 1 \rightarrow 0.1A^{o}$) and very high frequency that means x–ray photons carry very high energies so as a result these photons have a very high penetration power. The discovery of x-rays was accidental by a physicist called W. C. Roentgen in 1895, this ray is very useful in diagnosis & radiotherapy.

❖ **Attenuation: is** the reduction of the intensity of an x-ray beam as it traverses matter. The reduction may be caused by absorption or by deflection (scatter) of photons from the beam and can be affected by different factors such as beam energy and atomic number of the absorber. An attenuation coefficient is a measure of the quantity of radiation attenuation by a given thickness of absorber

❖ **Computed Tomography**: is commonly referred to as a CT scan. A CT scan is a diagnostic imaging procedure that uses a combination of X-rays and computer technology to produce images of the inside of the body. It shows detailed images of any part of the body, including the bones, muscles, fat, organs and blood vessels.: Figure (1)

Figure (1): Computed Tomography

working principle

The images are made by converting electrical energy (moving electrons) into X-ray photons, passing the photons through an object, and then converting the measured photons back into electrons. The number of X-rays that pass through the object is inversely proportional to the density of the object. Objects (such as human beings) imaged by CT consist of parts that vary in density.

Radiation dose of computed tomography :The radiation dose received from CT examinations depends on the type of the CT scanner and examination, the size of the body part examined, and the image acquisition parameters (such as kVp, mA, exposure time, X-ray beam collimation, scan pitch, dose reduction options, etc.)

- The gantry includes the x-ray tube, the detector array, the high-voltage generator, the patient support couch

- Multislice helical CT x-ray tubes are very large. They have an anode heat storage capacity of 8 MHU or more. They have anode cooling rates of approximately 1 MHU per minute because the anode disc has a larger diameter, and it is thicker
- CT x-ray tubes are expected to last for at least 50,000 exposures.
- Detector array converts the projection values, in the form of radiation intensities, into electrical quantities.
- All multislice helical CT imaging systems operate on high-frequency power
- It uses special x ray equipment to obtain a set of image data at different angles around the human body The set of data processed in a computer to show a cross section of human body tissues and organs
- By using CT scan we can produce clear 2 D or 3 D cross sectional images of deep internal organs.

❖ **Advantages and Disadvantages of CT Scan**

Advantages

1. CT scan offers detailed views of tissues like lungs, bones, soft tissues and blood vessels.

2. CT scan is painless, noninvasive and accurate.

3. CT scan is quick and simple. In trauma cases, it can reveal internal injuries and bleeding quickly so as to save lives.

4. Diagnosis with the help of CT scan has the potential to eliminate the need for invasive exploratory surgery and surgical biopsy

5. CT scan can distinguish between normal and abnormal structures. It is a useful tool to guide radiotherapy, needle biopsies and all minimally invasive procedures.

6. CT scan is a cost-effective imaging tool for a wide range of clinical problems.

❖ **Disadvantages**

1. CT scan involves exposure to X-ray radiation. The radiation dose from this procedure is equal to a dose that the average person receives from background

radiation in three years, but the benefit of an accurate diagnosis far outweighs the risk

2. Pregnant women cannot undergo CT scan.

3. Lactating mothers cannot breast feed for 24 hours after contrast injection.

4. The contrast material injected may lead to allergic reaction

5. This gives images of only transverse sections of the body.

❖ **Limitations of CT Scan**

1-Very fine soft-tissue details in areas such as the knee or shoulder may not be revealed using

2-CT scan. It can be more readily and clearly seen with the magnetic resonance imaging (MRI)

3-The CT scan is not generally suitable for pregnant women

❖ **Major Application Of Ct Scan**

1. To investigate multiple organ injury due to trauma and accidents
2. To confirm the presence of cysts, solid tumours in various parts of the body
3. To know the size and extent of damage of organs as a result of the lesions
4. To investigate problems related to the spinal cord such as osteoporosis
5. To diagnose the sudden abdominal pain, blood in the urine, and renal infection
6. To ensure presence of tumor and to determine the stage of a tumor
7. To identify stones in the urinary bladder
8. To plan radiation treatments for tumors
9. To detect small bone injuries